Wm Horatio Allen

THE

RAILROAD ERA.

FIRST FIVE YEARS

OF ITS

DEVELOPMENT.

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[From the *Railroad Gazette*.]

THE article that follows had its origin in my having accepted the special invitation of the Commissioners of the "National Exposition of Railway Appliances," to be held in Chicago in June, 1883, to visit the exhibition, and at the appropriate time present such reference to early railroad development as circumstances permitted. My friends of the *Railroad Gazette* informed me that in such event they would have stenographic notes taken for a report that would appear in their paper.

When the time came, circumstances did not permit so full a presentation as the subject called for, and on the receipt of the report prepared for the *Gazette* I decided to make it more complete, and that what was thus summarily presented might meet the eyes of many to whom it would be of interest in this land, where the railroad era has perhaps its greatest development, to have it also before the public in pamphlet form.

HORATIO ALLEN.

HOMEWOOD, South Orange, N. J.

THE RAILROAD ERA.

THE FIRST FIVE YEARS OF ITS DEVELOPMENT.

[From the *Railroad Gazette.*]

By Railroad Era, is meant the era commencing with the permanent and successful use of the locomotive on the Stockton and Darlington Railroad, in England, in the year 1825, that has seen within less than sixty years, the iron track laid in so many lands, on which locomotives are performing their great work in the transportation of passengers and freight.

The time and circumstances of the professional life of a civil engineer had placed me early in the field, as the era opened, and thus of necessity occurred a personal knowledge of the very beginning of the era in England as well as in this country.

Although often requested, and sometimes by formal resolutions of societies of which I have had the honor to be president, to commit to print what was on many occasions the subject of interesting reminiscences, I have omitted to this late day these summary statements, in part, perhaps, for the reason that they are insomuch of a personal character.

But recently an occurrence led me to put these reminiscences into some connected relation, which, being made more complete, the following pages are placed before the public.

It is proposed to present the facts, occurrences, and decisions in their order of the FIVE YEARS that followed the introduction

of the locomotive on the Stockton and Darlington road in England, in September, 1825. During that period was determined essentially the character of the development of the railroad era, in all of which this country took an early and active part.

As preliminary to setting forth what occurred in the period named, it is of direct interest to go back to the invention that made a locomotive possible.

THE CONDENSING STEAM-ENGINE NOT THE LOCOMOTIVE ENGINE.

It will be recollected that the first use of steam to do work was in co-operation with the atmosphere to raise water from the bottom of a mine, some twenty-five feet, and then to force the water many more feet to the surface.

The successive improvements in this water-raising use of steam in co-operation with the atmosphere, led, when the invention of Newcomer came into the hands of Watt, to the condensing steam-engine. In that engine steam was used at a pressure of only seven pounds to the square inch greater than the pressure of the atmosphere, and water in large quantity was necessary for condensing the steam. The condensing steam-engine was therefore entirely inapplicable as a motive power on a railroad. The locomotive, therefore, does not date back to the steam-engine as it came from the hands of Watt.

THE HIGH-PRESSURE ENGINE, THE NON-CONDENSING ENGINE, THE LOCOMOTIVE ENGINE.

It is remarkable that the condensing steam-engine of Watt, being the subject of a patent, and its use only to be had on payment of a large patent fee, it was only when that patent was nearly at its close, that some one had the boldness to use steam of so great a pressure as to bid defiance to the resistance of the

atmosphere, and to plan and build an engine of the extreme simplicity that is the case when the steam, on leaving the cylinder, forces the atmosphere out of its way and is condensed in the open air. About the year 1800, the boiler, engine, and appurtenances that make the high-pressure engine, an engine that was to use steam of fifty pounds pressure instead of seven pounds, and therefore relatively a high-pressure engine, was the subject of a patent issued to Trevithick and Vivian; and not long afterward a high-pressure engine, boiler, and appurtenances were constructed and set to work. They were followed by the application of the high-pressure engine and boiler to turn the wheels of a carriage that carried boiler, engine, etc., the object being to use steam power, applied to turn the wheels, and thereby haul other carriages carrying loads. In plan and principle, the parts and combinations included all that is essential to the locomotive as a tractive motive power.

But the results of the trials made were not of a character to make the locomotive date from the time and acts of Trevithick and Vivian; and some years were to pass before a locomotive built under the direction of George Stephenson was put to work on a mine railroad at Killingworth, near Newcastle. The Killingworth locomotive was the antecedent of the locomotive put to work on the Stockton and Darlington road, a quarter of a century after the high-pressure engine of Trevithick and Vivian.

THE HIGH-PRESSURE ENGINE AND LOCOMOTIVE COMBINATION OF OLIVER EVANS, OF PA., U. S., 1776.

But before proceeding to state what was done by Stephenson, it is of interest on this side of the Atlantic to refer to what was proposed, tried, and proved in relation to the high-pressure engine, and to the locomotive engine as a tractive power on a road, by that remarkable man, Oliver Evans, of Pennsylvania.

As early as 1780, and before Watt had perfected and introduced the condensing engine, Oliver Evans had matured his plan of a high-pressure engine, and had applied it to do work as a stationary engine.

It is of interest to know that the boiler which Oliver Evans constructed and used was a *multitubular* boiler, but differing from the multitubular boiler, now the established boiler of the locomotive, in the particular that in the Evans boiler the water was in the tubes, and the products of combustion passed between the tubes, whereas in the present locomotive boiler the products of combustion pass through the tubes and water surrounds them. What was accomplished by Oliver Evans had all the elements of a permanent success.

Had Evans had a Bolton, as Watt had a co-operating Bolton, or a Pease, as George Stephenson had his Pease as a co-operator, the high-pressure steam-engine, both as a stationary and as a tractive motive power, would have had a position from that time of great interest to this country, and through this country to the world; but no such aid coming from individual or State, vainly applied to, there is only the record of what might have been—another of the many cases where the inventor was ready, but the age was not.

STEPHENSON'S KILLINGWORTH LOCOMOTIVE, 1814.

In 1814 George Stephenson placed on the mine railroad at Killingworth, near Newcastle, a locomotive in all its essential parts and combinations.

At that time the high-pressure engine had become known to such extent that Stephenson probably was not the inventor of the high-pressure engine, which formed so vital a part of his combination.

Although in daily use for several years, this locomotive did not attract attention. Its inefficient operation was due mainly to the use of a boiler of limited steam-making capacity.

THE OPENING OF THE RAILROAD ERA.

STEPHENSON'S STOCKTON AND DARLINGTON LOCOMOTIVE, SEPTEMBER, 1825.

But the time came when the construction of the Stockton and Darlington Railroad, a coal mine railroad, under the direction of Stephenson, afforded the opportunity for the locomotive, and with the opportunity came the co-operating man. That man was Pease, a member of the Society of Friends. Mr. Pease had a large interest in the Stockton and Darlington Railroad, and was so much impressed by the statement and explanation of Stephenson as to what was done and what might be done by the locomotive, as a tractive motive power, that, accompanied by Stephenson, he went to the Killingworth mine railroad to inform himself as to the locomotive at work there.

The result of this visit was that Mr. Pease, a friend of Mr. Pease, and Mr. Stephenson, united in providing the money for the construction of the locomotive that was put to work on the Stockton and Darlington road in September, 1825, and its success opened the railroad era.

The performance of this locomotive, although satisfactory to a great degree to the parties specially interested, again made known that the boiler was not yet of the steam-making capacity that could be had of a weight not exceeding the limit of weight admissible on a railroad. The attention thus excited had as one result the multitubular boiler, the invention of Mr. Booth, of the Liverpool and Manchester road, then in progress of construction, and also the boiler proposed by John U. Rastreck, of

Stourbridge, which may be called the many-flue boiler, using riveted flues of as small diameter as could be made by riveting.

In the year 1827 the locomotives on the Stockton and Darlington road were doing their daily work; the advocates of the locomotive as the future motive power were claiming the greater results that were to attend the use of boilers of greater efficiency in the locomotive. But as yet the question was a debatable one; and the extent to which it was debatable will be strikingly presented by two acts of great significance, which are made the more remarkable by the fact that George Stephenson had become the Chief Engineer of the Liverpool and Manchester Railroad, then in progress of construction. But it is to be recollected that George Stephenson had not at that time risen to the position as an authority which he subsequently held.

ANTICIPATION IN THE UNITED STATES OF THE COMING RAILROAD ERA IN 1827.

The reference to what was done and what was not done by the Liverpool and Manchester Railroad Company, is postponed at this state of questions to be decided, because the action of other parties came in at this time, which in its results is of special interest to this country.

The reference to this action is of necessity personal, and it is to be borne in mind that it is only as matter of history that the successive statements that follow are made.

During the years 1826 and 1827, the use of the locomotive on the Stockton and Darlington road had become known to many, and especially to civil engineers in this country, and among others to myself, then a Resident Engineer on the line of the Delaware and Hudson Canal, the great engineering enterprise of the time, the first of the great works, canal and rail-

road, that were to bring the anthracite coal of the valley of the Susquehanna into the valley of the Delaware and of the Hudson, and to the ocean.

Such consideration as was within my power led me to a decided conviction as to the future of the locomotive as the tractive motive power on railroads for general freight and passenger transportation, as it had begun to be for mine transportation.

The same judgment as to the locomotive which I hold now I held then. A brief reference to the essential character of

THE LOCOMOTIVE AS A TRACTIVE POWER,

is not out of place in this reference to its introduction as the motive power on all railroads.

A horse having the power of onward motion in himself, that power is used as a *tractive* power on a railroad; when the horse is by harness and traces connected with a railroad car, and the resistance of the car to onward motion being less than the power of the horse, onward motion takes place. How is it that the locomotive, by its steam-engines and combination with the iron rails, has the power of onward motion, and therewith becomes a *tractive* force?

The reply to this question is not as simple and direct as it is usually considered to be; and as the full truth may be of interest to some readers, the following statements are added as pertinent to the subject in hand.

It is readily understood that if a locomotive is blocked up to a position at which the driving-wheels (the wheels on which the steam-engines act) are *not* in contact with the iron rail, and steam is let into the two steam cylinders, the two wheels will have rotary motion, and at great rate if desired.

Such being the result of the operation of the steam-engines

under the circumstances, suppose the locomotive to be lowered to the rails, and the weight of a large part of the locomotive, including boiler, engines, etc., rests on the rails through the driving-wheels, and that again steam is let into the cylinders; there being no cars attached to the locomotive, the locomotive at once has *onward motion.*

This onward motion is usually referred to the rotation of the driving-wheels, caused by the *direct* action on them of the two engines.

This is only in part true, and attention is to be directed to the *other* cause of onward motion.

When the crank-pin on the driving-wheel is on the *upper* half of one rotation, it is forced by the steam power acting on it to make that half rotation, and in consequence of that half rotation the locomotive has a certain onward motion; but when the crank-pin makes the *lower* half of the rotation, the steam in the cylinder, acting direct on the cylinder-head to cause onward motion-onward motion takes place; and with it, of necessity, the on, ward motion of the locomotive which carries the cylinder and the locomotive having onward motion, the wheels that carry the locomotive of necessity have rotary motion.

Thus, as a matter of fact, the onward motion for half of each rotation is caused by that half rotation, and the other half rotation is due to the onward motion of the locomotive.

But a more important question remains to be answered, viz.: How is it that in *either* case onward motion of the locomotive takes place?

The reply is that when steam acts on the combination, the motion yielding to its force can take place in one of *two* ways:

1. The wheels may *slip* on the rails.
2. The locomotive can have onward motion.

To each of these motions there is a resistance.

In the one, the resistance to *slipping* on the rail.

In the other, the resistance of the locomotive and its train to onward motion.

The word slip inadequately suggests the great resistance to *slipping*, that is the case when the surface of the wheel is forced into contact with the surface of the rail, by the weight of the boiler, engines, etc., of the locomotive. That weight often exceeds four tons to each wheel, or eight tons to the two wheels. The resistance to the slipping of the wheel under this great pressure, is the same as the resistance to movement along the surface of the rail, of eight tons of iron lying on the rail.

Experiment had long ago determined that the resistance to the movement of iron resting on iron, the surfaces not lubricated, exceeded one-eighth the pressure on the bearing surface; that is, that one ton suspended vertically and acting through a pulley, to move eight tons horizontally, would be required to move the eight tons along the rail.

The resistance to the onward motion of the locomotive and its train of cars, can be expressed with equal definiteness. Such being the relation of the two resistances, it is plain that as long as the resistance to onward motion of the locomotive is less than the resistance of the wheels to slip on the rail, the locomotive and its train will have onward motion; but if from any circumstance the resistance to onward motion becomes greater than the resistance of the wheels to slipping, then, of course, the wheels slip, and the locomotive stands still—an occurrence which often meets the eye of the traveller, when a train in motion on a level road commences the ascent of a rising grade for which the locomotive is not prepared.

Early in the year 1827, I had given all the attention that it

was in my power to give, and having come to conclusions as to the locomotive, that all subsequent experience has confirmed, and believing that the future of the civil engineer lay in a great and most attractive degree in the direction of the coming railroad era, I decided to go to the only place where a locomotive was in daily operation, and could be studied in all its practical details.

Closing my service on the Delaware and Hudson Canal, some two months were appropriated to certain objects and interests, after which I was again in New York, preparatory to going to England.

FIRST ORDER FOR A LOCOMOTIVE AFTER THE STEPHENSON LOCOMOTIVE IN 1825, BEING THREE FOR THE DELAWARE AND HUDSON CANAL COMPANY OF NEW YORK AND PENNSYLVANIA, IN 1827, AND BUILT IN 1828.

On my return to New York from these visits, I found that it had been decided by the Delaware and Hudson Canal Company to intrust to me, first, the having made in England for that company the railroad iron required for their railroad, on which the coal from their mines in the valley of the Lackawanna, a tributary of the Susquehanna, was to be transported across the mountain range which intervened, to the Lackawaxen, a tributary of the Delaware, whence by canal the valley of the Hudson was reached, and by the Hudson River the ocean was reached at New York; and, second, the having built in England for the company three locomotives, on plans to be decided by me when in England.

This action of the Delaware and Hudson Canal Company was on the report of their Chief Engineer, John B. Jervis, and thus it occurred that the first order for a locomotive engine, after the locomotives on the Stockton and Darlington road were at work,

came from an American company, on the report of an American civil engineer, now a resident at Rome, in the State of New York.

It was under these favorable circumstances that I left New York in January, 1828, and within two days after my arrival at Liverpool I made the acquaintance of George Stephenson, on the most agreeable relations, and from that time during my stay in England I received from him every kindness in his power, and all the aid to what I had come so far to seek, that was at his command, at Liverpool, on the Stockton and Darlington Railroad, and at Newcastle, at that time the centre of all that was in progress in railroad and locomotive matters.

FIRST ORDER FOR RAILROAD IRON FOR THE UNITED STATES BEING FOR THE DELAWARE AND HUDSON CANAL COMPANY, 1828.

The iron for the railroad first required attention, and as its manufacture, although executed in England, was on a plan of American origin, some reference to its manufacture is appropriate in this article.

The instructions which accompanied the authority to contract, etc., describe a mode of making the iron. On reading the description it appeared to me that a less expensive plan could be used. This I explained to the committee of the Delaware and Hudson Canal Company. It was thought proper to have the judgment of some one having experience in rolling iron, which I had not, as I had not even seen a bar of iron rolled. The proprietor of the only rolling-mill near New York, at the request of the committee, came to New York to consider the plan proposed, and after examination he stated that in his judgment the plan would not be a success. Nevertheless I thought it would be well to suggest the plan at the rolling-mills in England.

This being the first order for iron made expressly for a railroad from this country, it was deemed advisable to go to the mills and explain what was wanted, and to suggest one way in which the iron could be made, as it appeared to me. Of the seventeen mills visited, and from which proposals were received, only three thought well of my suggestion.

With one of the three, the Guests, of Merthyr Tydvil, a contract was made. When the time for examination of the iron came it was not satisfactory, and I said that I could not accept iron of that character; they refused to deliver any other.

Application was then made to W. & I. Sparrow, of Wolverhampton, another of the three, and reference to what had occurred at Merthyr Tydvil. I described very plainly what I expected. In reply I was informed that the intention in their proposals was what I had fully explained. The contract was therefore made with W. & I. Sparrow. My wish in this case to remain and see the preparations made being acceded to, the rolls to be fitted up were on hand, and in ten days the iron was being made on the plan proposed, and subsequently the iron was delivered in every respect satisfactory. The large amount of iron of the same character made for this country in after years, was all made on that plan. If the mechanical details of the plan were described, there would be surprise that there ever had been any question, or that it had been thought worth the time to refer to it.

THE BOILER OF THE LOCOMOTIVES THE GREAT QUESTION OF THE LOCOMOTIVE.

The order for the locomotive required the determination of the plan of boiler, and in order to that decision, and to the study of all matters in connection with the construction and use of

railroads, much time was passed at Liverpool in connection with the Liverpool and Manchester Railroad, on the Stockton and Darlington Railroad, at Newcastle, and at Stourbridge, the place at which were the works of Foster, Rastrick & Co., from whom proposals to furnish the railroad iron had been received.

As to the boiler, the result on my mind was a decided confidence in the multitubular boiler proposed by Mr. Booth, of the Liverpool and Manchester road, but I found in many a distrust of that plan of boiler as being an *untried* boiler. John U. Rastrick, of Stourbridge, of whose position on all railroad questions a very marked expression will be stated presently, recommended a boiler of small riveted flues of as small diameter as could be riveted, and in number as many as the end of the fire-box would allow.

Under the circumstances, it appeared to me that the responsibility resting on me would be more prudently met by the order of two locomotives from Stephenson, which were built at Newcastle, and one from Foster, Rastrick & Co., which was built at Stourbridge.

The plans of the locomotives, the proportions of parts, and all details, were left to the judgment of the builders, as their experience far exceeded mine.

The only points decided by me were that the boilers of the ocomotives built by Stephenson & Co. were to be multitubular boilers, the dimensions of the tubes to be decided by the builders; and that the boiler of the locomotive built by Rastrick & Co. (the "Stourbridge Lion") was to be a flue-boiler, the size and number of the flues to be decided by the builder.

As the locomotives were built after I left England, they were never seen by me until I saw them in New York, and I never saw the inside of any of the boilers until I saw the inside of the

boiler of the "Stourbridge Lion," at Chicago, in 1883; when, to a surprise so great that I could not believe that the inside of the boiler had not been changed, I found that the discretionary power placed in Mr. Rastrick had not been used in the manner agreed on after full discussion, and after I had yielded to his judgment in having a flue-boiler at all.

In the orders thus given in the early summer of 1828 for three locomotives, is presented the fact that the *first* order for a locomotive after the demonstration of the locomotive as a successful tractive power on the Stockton and Darlington Railroad in 1825, came from an American company on the report of their chief engineer, trusted to the discretionary action of an American civil engineer.

The three locomotives were received in New York in the winter of 1828 and 1829.

One of each kind was set up, with the wheels *not* in contact with the ground, and steam being raised, every operation of the locomotive was fully presented except that of onward motion.

The locomotive from Stourbridge received its name "Stourbridge Lion" from the fancy of the painter, who, finding on the boiler end a circular surface, slightly convex, of nearly four feet diameter, painted on it the head of a lion, filling the entire area, and in bright colors.

The river and canal being closed by ice, it was not until the opening of navigation in the spring of 1829 that access was had to the railroad at Honesdale, Pa., which is at the head of the canal and at the beginning of the railroad.

Returning to New York during the winter of 1828 and 1829, I refer to a brief connection with the Delaware and Hudson Canal Company, to present in striking contrast the financial resources of that time and the present. The Delaware and Hud-

son Canal railroad and mining development had been brought so near to completion and productive use, by the expenditure of a stockholder capital, that only $300,000 were required to bring into operation this great enterprise of delivering anthracite coal on the waters of the Hudson River, and by that river at tide-water at New York.

But so limited were the financial resources of the time, that it was found necessary to apply to the Legislature of the State of New York for the loan of the credit of the State to raise $300,000. In this application it was found necessary to meet the representations, afterward found to be gross misrepresentations, of those who took great pains to prevent any appropriation of money, private or public, to an enterprise so full of uncertainty. The representation made it necessary to prove that the coal transported would *burn*. Under these circumstances I was invited to pass a few weeks at Albany, to be of such use as might be.

When the time came that one of the locomotives was to be sent by river and canal to Honesdale, the "Stourbridge Lion" was sent.

How it happened that the "Stourbridge Lion" was sent I have no knowledge.

In reference to future events, so near by, it is to be regretted that one of the Stephenson locomotives was not sent, and for the reason that the locomotives built for the Delaware and Hudson Canal Company by Stephenson were the *prototypes* of the locomotive "Rocket," whose performance in October of the same year so astonished the world.

The two locomotives from Stephenson that were in New York early in the year 1829, and therefore prior to the trial of the locomotive "Rocket" in October of that year, were identical in boiler, engines, plan, and appurtenances with the "Rocket";

and if one of the two engines in hand ready to be sent had been the one used on August 9th, the performance of the "Rocket" in England would have been anticipated in this country.

To present the time and incidents of the "Stourbridge Lion," the first locomotive run on this continent, I have to continue my personal narrative.

THE FIRST LOCOMOTIVE RUN ON A RAILROAD ON THIS CONTINENT, AUGUST 9, 1829, AT HONESDALE, PA., ON THE RAILROAD OF THE DELAWARE AND HUDSON CANAL COMPANY.

Early in the summer of 1829 I had received the appointment of Chief Engineer of the South Carolina Railroad, a road to extend from Charleston, on the ocean, to a point opposite to Augusta, Ga., on the Savannah River, a road of about 150 miles in length, but I was not to go to Charleston to commence my duties until September. Being thus at liberty in July and August, I volunteered to go to Honesdale and take charge of the transfer of the locomotive from the canal-boat to the railroad track, within twenty feet and about eighteen feet above the level of the canal-boat.

The line of road was straight for about 600 feet, being parallel with the canal, then crossing the Lackawaxen Creek, by a curve nearly a quarter of a circle long, of radius 750 feet, on trestle-work about thirty feet above the creek, and from the curve extending in a line nearly straight into the woods of Pennsylvania.

The road was formed of rails of hemlock timber in section six by twelve inches, supported by caps of timber ten feet from centre to centre. On the surface of the rail of wood was spiked the railroad iron—a bar of rolled iron two and a quarter inches wide and half an inch thick.

As the locomotive was seen in mid-air, in its transference from the canal to the railroad, the opportunity was had to see that the axles had an unyielding *parallel* position, there being no king-bolt that provided facility for passing round the curve, and that, therefore, the four wheels holding their rigid position were to be forced round the curve by the power of the steam-engine. The locomotive thus seen altogether impressed the lookers-on as being of great weight. The road having been built of timber in long lengths, and not well-seasoned, some of the rails were not exactly in their true position when the time came that they were to carry the locomotive in its onward movement.

Under these circumstances the feeling of the lookers-on became general, that either the road would break down under the weight of the locomotive, or, if the curve was reached, that the locomotive would not keep the track, and in its onward motion without support it would dash into the creek with a fall of some thirty feet.

On my part, I knew that the road would carry the locomotive safely, and that the curve would be passed without any difficulty.

But when the time came, and the steam was of the right pressure, and all was ready, I took my position on the platform of the locomotive alone, and with my hand on the throttle-valve handle, said: "If there is any danger in this ride it is not necessary that the life and limbs of more than one should be subjected to that danger; that, having no doubt whatever, I was about to take the ride entirely alone, and that the time would come when I should look back with great interest to the ride that was now before me."

The locomotive, having no train behind it, answered at once

to the movement of the hand, and there being no doubt as to the result, a motion was had at once in which there was not any evidence of distrust; soon the straight line was run over, the curve was reached and passed before there was time to think as to its not being passed safely, and soon I was out of sight in the three miles' ride alone into the woods of Pennsylvania.

I had never run a locomotive nor any other engine before, I have never run one since; but on that 9th of August, 1829 I ran that locomotive three miles and back to the place of starting, and being without experience or a brakeman, I stopped the locomotive on its return at the place of starting. After losing the cheers of the lookers-on, the only sound, in addition to that of the exhaust steam, was that of a timber structure when the parts are brought into the bearing state.

Over half a century passed before I again revisited the track of this first ride on this continent. Then I took care to walk over it in the very early morning, that nothing should interfere with the thoughts and feelings that, left to themselves, would rise to the surface, and bring before me the recollections of the incidents and anticipations of the past, the realization of the present, and again the anticipations of the future.

It was a morning of wonderful beauty, and that walk alone will, in time to come, hold its place beside the memory of that ride alone over the same line, the interval being more than fifty years.

Again, in order to present the facts that it is the object of this narrative to present, I have to refer to my personal acts as a civil engineer.

In September of 1829 I was at Charleston, S. C., to enter on my duties as Chief Engineer of the South Carolina Railroad. I had already learned the general character of the country that

the road was to pass through, and the first question to be decided was that of the *motive power* to be used. I was prepared to submit a report on the subject at once. But before stating the character of that report and the decision of the board, it is pertinent that it be clearly understood what was the state of the question on both sides of the Atlantic as to the motive power to be used on a railroad intended for general freight and passenger transportation.

On this side of the water some sixteen miles of the Baltimore and Ohio road had been constructed, and was worked by horse power.

On the other side of the Atlantic, the Liverpool and Manchester Company was the only company that had the subject under consideration, but as yet had not come to a decision, although their Chief Engineer, George Stephenson, was the able and earnest advocate of the locomotive.

In their measures to have before them the fullest information on the subject, the company submitted the question of the motive for the Liverpool and Manchester Railroad to two eminent civil engineers for their judgment, after the most thorough examination.

REPORT OF TWO EMINENT CIVIL ENGINEERS IN FAVOR OF STATIONARY ENGINES ACTING THROUGH LONG ROPES.

The two engineers were James Walker, of London, and John U. Rastrick, of Stourbridge.

The two engineers concurred in an elaborate report, presenting their conclusion and plans in great detail.

That conclusion was not in favor of locomotive power, but was in favor of a succession of stationary engines transmitting a tractive force by use of long ropes.

No more impressive reference to the *undeveloped* character of the locomotive in England in 1825, can be presented than that found in the following extract from "Wood on Railroads," 1825:

"Nothing can do more harm to the adoption of railroads, than the promulgation of such *nonsense* (italic in the original) as that we shall see locomotives travelling at the rate of twelve miles per hour."

It is hardly necessary to add, that in a second edition a few years later, this caution of "Wood on Railroads" is not to be found.

In addition to the preceding, as showing that the locomotive had not in 1828 the position, in fact and feeling, that it rose to in a very few years, and so greatly below that it holds now, there is the remarkable item of history, that in 1829, the Liverpool and Manchester Railroad Co. deemed it necessary to appeal to the mechanical ability of the country, by a premium of $2,500, and the purchase of the locomotive, to obtain a locomotive that would haul on a level railroad *three times its own weight at ten miles the hour.*

To the knowledge of a general character as presented above, was added the personal knowledge of the locomotive as a tractive power as briefly presented herein, and the results of a practical study of the locomotive in its daily operation, at the only place in the world where the locomotive was in operation to be studied.

of Mr. Allen

REPORT TO THE SOUTH CAROLINA RAILROAD COMPANY, IN SEPTEMBER, 1829, IN FAVOR OF LOCOMOTIVE POWER AS THE TRACTIVE POWER ON THEIR RAILROAD OF 150 MILES LONG, FOR GENERAL FREIGHT AND PASSENGER TRANSPORTATION.

In that report was presented an estimate of the cost of transportation by horse power, and by locomotive power. The esti-

mate of cost by locomotive power was based on facts obtained on the Stockton and Darlington Railroad.

The result of that comparison was in favor of locomotive power, and the report contained a decided recommendation that locomotive power should be the power to be used on the South Carolina Railroad.

But the basis of that official act was not the simple estimate resting on the facts as they existed on the Stockton and Darlington Railroad, but, as was stated in the report, was on the broad ground that in the future there was no reason to expect any material improvement in the breed of horses, while in my judgment the man was not living who knew what the breed of locomotives was to place at command. Contrast the eight-wheel locomotive of this day with the four-wheel locomotive of the Stockton and Darlington Road, and find some evidence that the position then taken was well taken, and then bear in mind that *the end is not yet.*

This report was submitted at a full meeting of the Board, every member in his seat and the President in his chair. Without leaving their seats the decision was unanimous.

The resolution then passed, and placed on record, was the first act by a corporate body in the world to adopt the locomotive as the tractive power on a railroad for general passenger and freight transportation.

THE SOUTH CAROLINA RAILROAD—ITS CONSTRUCTION.

The South Carolina Railroad was of the age of wooden rails capped with iron. Confidence and capital had not yet reached the growth to make an iron track of the most modest weight per yard a possibility, and steel rails were as unthought of as the telegraph.

On timber rails, six-inch by twelve-inch section, iron bars two and a half inches by half an inch were spiked. The wood was the Southern pine, the hard, resinous surface of which was as suitable for the iron bars as wood could be.

I desired to use iron of the same width and thickness, but with a flange on one edge, but the cost per mile multiplied by 150 had too large a product for the treasury of the company; and the expense was incurred only on the curves, which being few and small in extent, the expense was admissible.

The limit of weight under each wheel where the road was of the material and combination of necessity used, and the equal necessity of more power in one locomotive and under the command of one engineer, led naturally to the combination allowing the use of more wheels, and thereby providing more boiler, and therewith a less severe action on the road than was the case with the four-wheel locomotive with its overhanging fire-box.

REPORT TO SOUTH CAROLINA RAILROAD COMPANY AS TO THE NECESSITY OF SIX AND EIGHT-WHEEL LOCOMOTIVES.

The necessity of such provision led to the submission of a special report on the subject, in which the necessity was fully presented, and in which were described the parts and combinations by which provision was made for the change in the direction of road and the changes in grade, accompanied by the plans in detail.

The provisions thus made and introduced are those now in use in six and eight-wheel engines. In the freedom from severe action on the road was attained a result of specially great value when the road was a combination of wood and iron. The authority to incur the responsibility and expense was not easily obtained. The fact that the combination was new was almost

too great an objection for the necessity, plain as that necessity was.

The special objects sought in the six and eight-wheel combination were fully attained, viz.: that of a locomotive of the steam-making capacity, determined by the weight to which each of eight wheels was limited by the material and construction of the railroad, together with the equal distribution of the weight, and the necessary provision for changes in direction and changes in grade. Since that day the numerous improvements of the eight-wheel locomotives, especially in this country, have sustained what was introduced at so early a date, and again it is to be said, "The end is not yet."

One result of the early introduction of the eight-wheel locomotive has been of indirect benefit to every railroad corporation in the country.

The well-informed in the railroad history of this country will recollect the successive trials in connection with the use of the eight-wheel passenger cars, claimed to be made under valid patent. In the four-wheel engines the boiler carried the cylinders, and was, in fact, the frame carried by the running gear. In the eight-wheel engine the boiler in like manner carried the cylinders, and, in fact, was the frame carried by the swiveling trucks.

To form the eight-wheel passenger car it was only necessary to substitute for the boiler a long body of a passenger car, to be carried by the same swiveling trucks, and the eight-wheel passenger car existed. The models presenting this substitution, in court decided the question.

The first time over 100 miles were run in continuous line was on the South Carolina Railroad.

It will be readily understood that in this early use of a rail-

road by locomotive power, the *railroad appliances* of various kinds were matters of necessity, but without antecedents. To any one who may happen to know what was *devised* and *done* at that early day, it is pertinent and fair to say that the engineer on whom rested the responsibility of providing the indispensable, also knew with what difficulty the capital, in that day of small capital and little confidence, had been provided by subscription to the stock of the company, and with what greater difficulty any addition to that capital could be had until success had attended the original sum provided. It was, therefore, an indispensable condition of every plan to be devised that its cost must come within the capital provided.

With such determination was this condition kept in view, that it was a pleasantly repeated remark, in after times, for the engineer to be introduced by a former director, as the engineer who had built and put in operation a railroad within his estimate.

TRIAL OF LOCOMOTIVE SERVICE IN THE NIGHT.

To one incident in this early use of the locomotive on a long road for general freight and passenger transportation, reference will be made, not as of any value in itself, but in this case as of interest in my recollection of the attendant circumstances.

That the locomotive was to be used in the night, and during the whole night, was plainly to be anticipated. It was thought well to make trial of such running by night, that it might be known what it was necessary to provide. For such trial two platform cars were placed in front of the locomotive. On the forward platform was placed an inclosure of sand, and on the sand a structure of iron rods somewhat of urn shape. In this structure was to be kept up a fire of pine-wood knots. Suitable signals as to the rate of speed, etc., were provided. The day preceding

the evening of the trial closed in with as heavy a fog as I have ever seen, and I have seen a first-class London fog. But the fog did not prevent the trial when the appointed time came.

The country to be run through was a dead level, and on the surface rested this heavy fog; but just before we were ready to start, the fog began to lift and continued to rise slowly and as uniformly as ever curtain left surface of stage, until about eighteen feet high; there it remained stationary, with an under surface as uniform as the surface it had risen from. This under surface was lit up with radiating lines in all directions with prismatic colors, presenting a scene of remarkable brilliancy and beauty.

Under this canopy, lit on its under surface, the locomotive moved onward with a clearly illuminated road before it; the run was continued for some five miles, with no untoward occurrence, and I had reason to exclaim, "The very atmosphere of Carolina says, 'Welcome the locomotive.'"

The five years that follow the five years that have been thus summarily referred to are not without interest in relation to the part taken in this country in the further development of the Railroad Era. And when we come to the time when the night was made available to the travellers on Railroads with so great economy of time and with so much comfort, it is found that very much of personal interest originated in this country.

It is well and pleasant to know that of the two English-speaking peoples by whose action the Railroad Era was opened and has been developing, we, on this side of the waters that intervene, but do not separate, have in the past fully done our part.

To extend this knowledge to many to whom it will be of interest is the object of these few pages put into print.

They who in the knowledge of the past and study of the

present are prepared to speak of the fuiure, may say "that while the end is not yet, the place in this great Era earned by this country in the past will be sustained in the future."

RAILROAD GAUGE.

The distance from edge to edge of the two iron rails that form the railroad track, is called the railroad gauge.

As the gauge of the railroads in the North in the United States was practically, it may be said incidentally, decided during the five years referred to, it is pertinent to these statements to refer to its origin.

The gauge of the Stockton and Darlington Railroad, a coal mine railroad, determined the gauge of the railroads in the United States.

When George Stephenson, having been chief engineer of the Stockton and Darlington Railroad, became the chief engineer of the Liverpool and Manchester Railroad, he adopted four feet eight and a half inches, the gauge of the Stockton and Darlington Railroad, as the gauge of the first railroad to be constructed for general freight and passenger transportation. There is no statement as to the grounds of this important decision.

It is plain that there were some conditions to be complied with in connection with the Stockton and Darlington road, that made the use of the half inch of value. It is also plain that there were no such conditions on the line of the Liverpool and Manchester Railroad. Why that liberty was not used we have no knowledge.

When the time came for action as to the width of gauge in the United States, at the North, there was also no limitation, but again the coal mine railroad gauge of four feet eight and a half inches was adopted, because it was the gauge of the Liver-

pool and Manchester Railroad, and in their turn as other railroads were built at the North, the four feet eight and a half inch gauge was adopted. In only two cases were there omissions to follow the precedent thus established.

One was by the South Carolina Railroad Company, who, in accordance with the report of the chief engineer, adopted five feet as the width of gauge on their railroad.

In that report were presented, as far as known at that time, the conditions to be complied with in reference to the locomotive, the railroad cars, freight and passenger, with due reference to cost of road-bed.

This action of the South Carolina Railroad determined the gauges of the Southern road, which continues of that gauge to this time; but it is to be anticipated that the commercial advantages of uniformity of gauge will eventually narrow the gauge down to the coal mine gauge of four feet eight and a half inches.

The other case referred to is that of the Erie Railroad. The gauge adopted for that road was six feet, known as the Broad Gauge. Of that gauge were the seventy-five miles, known as the Eastern Division, and used for many years.

When the time came that it was believed that provision had been made to build the road to Lake Erie, the question was raised again as to width of gauge. Being at the time consulting engineer of the company, the question was referred to me.

In the report submitted in reply, the conditions as to locomotives and railroad cars were made the basis of the judgment, and again the five-foot gauge was the conclusion.

The conclusion was concurred in as an engineering question, but the action of the company was to adhere to the broad gauge, and mainly for financial reasons.

Many years afterward the commercial advantages of uniformity of gauge caused the change of gauge to the four feet eight and a half inch gauge.

HORATIO ALLEN.

PERSONAL REFERENCE TO THE DELAWARE AND HUDSON CANAL COMPANY.

The reference in the preceding statements to the early action of the Delaware and Hudson Canal Company in the use of railroad transportation, and specially to their order for first locomotives, after the locomotives in use on the Stockton and Darlington Railroad; and the reference to my connection with the construction of the Delaware and Hudson Canal, which led to the important railroad trusts placed in my hands, afford me the opportunity of expressing therewith, what I have always felt, my appreciation of the professional obligation I was under to the Delaware and Hudson Canal Company, and to their Chief Engineer, John B. Jervis, by whose counsels their action was determined.

HORATIO ALLEN.